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ABSTRACT

The purpose of this study was to investgate the role of self-efficacy expectations in understanding gender differences in the election of college computer science courses. Participants were 368 undergraduate students (males=104, females=264) enrolled in a course fulfilling a general education requirement at a large urban university. A two-page questionnaire was used to assess six background variables: gender, year in school, age, major, microcomputer ownership, and nonschool computer use. The behavioral outcome variable--enrollment in a computer science class--was assessed by asking students if they were currently enrolled in or had previously taken a computer science course in college. Three additional outcome variables were also measured; however, the major part of the questionnaire focused on the assessment of self-efficacy with regard to three different aspects of computer literacy: (1) computer programming, (2) computer courseware, and (3) personal uses of computers. Perceived self-efficacy for each section was computed by dividing the total confidence ratings by the number of tasks in that section. Results indicate that gender differences exist in perceptions of computer self-efficacy; in addition, self-efficacy concepts are positively related to plans to enroll in a computer science course and experience with computer programming. While causality cannot be inferred from these relationships, it is reasonable to conclude that those most likely to perceive themselves as efficacious in computer-related tasks would be more likely to attempt a computer science class and to persist despite difficulties encountered. A list of references and two data tables are provided. (JB)

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Computer self-efficacy: A factor in understanding gender differences in computer course enrollment

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Computer self-efficacy: A factor in understanding gender differences in computer course enrollment

Despite recent attempts to recruit and retain women in the fields of mathematics and technology, they continue to be underrepresented in these domains. Women were only 11 percent of United States graduates earning engineering bachelor's degrees in 1982 (US National Center, 1985). In that same year, thirty-five percent of the bachelor's degrees in computer and information science were awarded to women; a gain of five percent from 1980 (Fact-file, 1981). These latter statistics include both the computer science curriculum that emphasizes science, electronics, and mathematics, and the business-related curriculum that is comprised of business data processing and management information systems (Teagarden, 1983).

Outside the computer science major, the college disciplines that typically require computer science coursework are those in engineering, the natural and physical sciences, and mathematics--all math-related and traditionally male-dominated majors. However, competence in mathematics and technology is becoming an important prerequisite for a wide (and growing) number of occupations. As in careers in mathematics and natural sciences, careers in business and the social sciences are requiring a strong background in math and computing because of the increased reliance on statistics and computer technology in those fields (Markoff, 1983).

A survey of student course choices over a twenty-year period indicated that women appear to be more sensitive than men to established measures of their abilities (e.g., SAT scores) when choosing a college major (Boli, Katchadourian, & Mahoney, 1983). Without high mathematics ability, women tended to avoid the technical disciplines almost completely. The same trends were noted for men, but they seemed less dependent upon confirmation of math ability in making these choices.

Jagacinski, LeBold, and Salvendy (1985) examined persistence in technical majors. Men in their survey were more likely than women to persist in electrical/computer engineering and computer science. Using a stepwise discriminant analysis, they found that for men, verbal as well as math abilities were important factors to discriminate between persisters and non-persisters in computer science. For women, college GPA, a measure of mathematics ability, and high school rank were selected in the stepwise procedure. High school rank was weighted negatively in the dicriminant function indicating that women may drop the computer science major when current grades do not meet expectations that are based on past high school performance. The researchers suggest that there may be additional nonacademic factors such as goals, perceived encouragement, and expectancies that may also affect persistence.

The purpose of this study was to investigate the role of self-efficacy expectations in understanding gender differences in the election of college computer science courses. Specifically, the study investigated the differences between men and women college students in their perceptions of self-efficacy regarding computer-related activities and the relationship between self-efficacy expectations and enrollment in a computer science class, plans to take a computer science course, perceptions of the utility of computing skills for one's future career, and interest in knowing more about computers. It was hypothesized that men and women would differ in their perceived self-efficacy and that this in turn would differentially affect the behavioral and cognitive outcome measures.

People's perceptions of their capabilities are likely to influence how well they prepare themselves for different career pursuits. Research conducted within the framework of self-efficacy theory (Bandura, 1977a, 1977b) has begun to delineate the determinants and psychological effects of such self-appraisals. A self-efficacy judgment is the belief that one can execute successfully a certain course of behavior. Bandura has proposed that perceptions of self-efficacy regarding a task can influence the choice to engage in that task, the effort that will be expended in performing it, and the persistence that will be shown in accomplishing it. Research evidence generally supports these propositions (Bandura, 1982).

According to Bandura, one important source of information affecting perceptions of self-efficacy is performance accomplishment. People's perceived self-efficacy for an activity tends to increase if their experiences provide positive information about related competencies. Males tend to seek out interaction with computers (through curricular and extracurricular classes and informally in video arcades, thereby creating opportunities for successful performance on the machine (The College Board, 1984; Hess & Miura, 1984; Kiesler, Sproull, & Eccles, 1983; Naiman, 1983). Because computer science is a math-related subject, performance accomplishment in mathematics may also affect perceptions of efficacy with regard to computers. In addition, sex differences in locus of control (Dweck & Bush, 1976), especially as it affects mathematics and math-related performance, may indirectly contribute to these self-efficacy expectancies.

Seeing others succeed or fail is a second source of information that can affect perceived self-efficacy. For males, successful role models in math-related careers are numerous, while for females, they are relatively few (Hackett & Betz, 1981). Television and magazine advertisements for home computers that feature boys using and learning from computers, as well as a lack of interesting software for girls (Miura & Hess, 1983), may contribute to the subtle message that computer-related activities are more suitable for males.

Perceptions of self-efficacy are affected by a third source of information; verbal persuasion. Girls in the United States are not actively encouraged to continue in mathematics classes and are often discouraged from pursuing a math-related career. Counselors and teachers can have either a positive or negative influence on course-taking, and it would appear that encouragement is more often directed to boys than to girls (Brody & Fox, 1980). Parental encouragement for computer-related activities also seems to be an important factor for both men and women in the selection of a computer science major (Dachey, 1983). However, this encouragement may be given more to boys than to girls (Hess & Miura, 1984).

A final source of information that can contribute to the development of efficacy expectancies is emotional arousal. Individuals are more likely to feel efficacious if they are not highly anxious. Those who have been the strongest promoters of computer literacy at the pre-college level have been the math instructors (Saunders, 1978), and the first educational computer programs were primarily arithmetic drill-and practice. Sex-stereotyping of mathematics as a male subject begins early (Stein & Smithells, 1969), and mathematics anxiety, or lack of confidence in one's ability to do math, begins to emerge in the junior high school years. It appears that this anxiety may be transferred to the computer (Winkle & Mathews, 1982). Math anxiety also occurs among college students (Betz, 1978); consequently, because many college computer science courses have mathematics prerequisites, math anxiety may influence perceptions of self-efficacy for computer activities at the college level as well.

Method

Three hundred sixty-eight undergraduate students (males=104; females=264) provided usable data. The students were enrolled in a course fulfilling a general education requirement at a large, urban university in California, and are a representative cross-section of the student population.

A two-page questionnaire was used to assess six background variables; gender, year in school, age, major, microcomputer ownership, and nonschool computer use. The behavioral outcome variable, enrollment in a computer science class, was assessed by asking students if they were currently enrolled in or had previously taken a computer science class in college. Three additional outcome variables were measured on a scale ranging from 1 to 5 (5=definitely; 4=probably; 3=maybe; 2=doubtful; 1=definitely not): plans to take a computer science course at this university if the subject had not already done so, perceived importance of computing skills in the subject's future career, and interest in learning how a computer operates.

The main body of the questionnaire consisted of three sections that were designed to measure self-efficacy with regard to three different aspects of computer literacy: computer programming, computer coursework, and personal uses of the computer. In each section, five tasks were listed in order of difficulty. For each task, students were asked to rate their perceptions of self-efficacy following Bandura's procedures. Subjects were asked to check if they felt they could perform the task, and for each task checked, to rate their confidence in their ability to perform the task on a scale of 10 (not very confident at all) to 100 (completely confident). Perceived self-efficacy for each section was computed by dividing the total confidence ratings by the number of tasks in that section.

Results

There were no significant differences for subjects grouped by age or year in school. Consequently, all ages and years were combined for the analyses.

Gender differences. When grouped by gender, one-way analyses of variance showed that men scored themselves higher on all three aspects of computer self-efficacy: computer programming (*Ms*: males=46.20, females=26.23; $F(1,365)=40.26$, $p<.001$); computer coursework (*Ms*: males=56.04, females=37.65; $F(1,361)=24.09$, $p<.001$); and personal uses of the computer (*Ms*: males=55.54, females=39.13; $F(1,361)=17.36$, $p<.001$). (See Table 1.)

When these data were analyzed separately for those who had not previously taken a college computer science course, the differences for computer programming (*Ms*: males=31.00, females=20.56; $F(1,250)=7.61$, $p<.01$) and for computer coursework (*Ms*: males=45.39, females=34.76; $F(1,248)=4.50$, $p<.05$) remained statistically significant. For those who had taken a college computer science class, the mean self-efficacy ratings were higher for both men and women, but the gender differences continued to be significant: computer programming (*Ms*: males=59.47, females=45.52; $F(1,113)=7.98$, $p<.01$); computer coursework (*Ms*: males=65.11, females=47.64; $F(1,111)=8.23$, $p<.01$); and personal uses of the computer (*Ms*: males=69.52, females=59.92; $F(1,111)=3.30$, $p<.01$).

There were also significant differences between males and females with regard to whether they had been or were currently enrolled in a college computer science class, $X^2(1, N=368)=24.10$, $p<.001$ and $X^2(1, N=368)=13.57$, $p<.001$ respectively. Fifty-three percent of the men had taken or were taking such a course compared to only 23 percent of the women.

Those students who had not taken a computer science class at this university were asked the certainty of their plans to do so. These responses also differed in favor of males (Ms: males=3.76, females=3.27; $F(1,302)=13.05$, $p<.01$). Among those who had taken a college course (presumably at another college), the males were more positive in their plans to take a computer science course at this university (Ms: males(N=25)=3.92, females(N=31)=2.58; $F(1,54)=14.36$, $p<.001$). (See Table 1.)

Women and men differed significantly in their reported college majors. The two most popular majors accounting for 53 percent of the men's responses were engineering and business. Social sciences and applied arts and sciences (e.g., health sciences, nutrition, and journalism) were the two most common majors reported by 51 percent of the women, $X^2(6, N=355)=67.30$, $p<.001$.

Responses to the question, "Will knowing how to use a computer be important in the career you choose?", differed significantly in favor of males (Ms: males=4.03, females=3.55; $F(1,360)=15.39$, $p<.001$). Males also reported greater interest in knowing how a computer works (Ms: males=3.68, females=3.04; $F(1,360)=19.11$, $p<.001$) (Table 1). This discrepancy may be a function of college major; not surprisingly, engineering and business majors gave higher ratings for the relevance of computing skills to their future careers (Ms: 4.39 and 4.28 respectively) than did those students majoring in social science (M=3.39) or applied arts and sciences (M=3.24).

Thirty-four percent of the men and 28 percent of the women reported having access to a home-microcomputer. This difference was not statistically significant. In addition, computer use outside of school did not differ by gender.

Correlational analyses. The three self-efficacy scores were fairly highly correlated with r's = .49 to .64; therefore, these three sections were combined into one perceived self-efficacy composite scale. The reliability of this measure was computed using Cronbach's alpha (α =.79).

There were significant positive correlations between the self-efficacy scale and the outcome measures of plans to take a computer science course ($r=.19$, $p<.001$), perceptions of the relevance of computing skills for a future career ($r=.39$, $p<.001$), and interest in knowing more about computers ($r=.31$, $p<.001$). As might be expected, completion of a high school computer programming course and current and past enrollment in computer science classes were positively related to the self-efficacy scale (all $p<.001$) (Table 2).

Regression analyses. For the group as a whole, gender, college major, computer ownership, high school computer programming course, past enrollment in a college computer science class, and current course enrollment accounted for 27 percent of the variability in the self-efficacy scale. The most important predictors were college major, high school course, and past enrollment in a computer science class (all $p<.001$). Computer ownership and gender were also significant predictors ($p<.05$ and .10 respectively). For women, the main predictor was high school programming course ($p<.001$), followed by college major and past enrollment in a computer science course (both $p<.01$). Computer ownership was also a significant

contributor to perceived computer self-efficacy for women ($p < .05$). The regression equation for men was identical except for the removal of computer ownership as a significant predictor variable.

Conclusions and educational implications

The results of this study indicate that a gender difference exists in perceptions of computer self-efficacy. The study also suggests that self-efficacy percepts are positively related to plans to take a computer science class while in college. Moreover, current and past enrollment in a computer programming course were positively related to computer self-efficacy. Of course, causality cannot be inferred from these relationships, nor can we be certain of the direction of effects. However, if we accept Bandura's argument that perceived self-efficacy can affect one's choice of situations, the effort that will be expended, and the persistence shown, then it is reasonable to conclude that those who perceive themselves as efficacious in computer-related tasks would be more likely to attempt a computer science class and to persist despite difficulties encountered.

Completion of a high school computer programming course, college major, and past enrollment in a college computer science class were the most important predictors of computer self-efficacy overall. A plausible explanation might be that performance accomplishments in high school computer science may contribute to perceived computer self-efficacy which in turn may affect choice of a college major. Those majors requiring computer science coursework would offer additional opportunities for positive experiences with computing, thereby raising perceived self-efficacy even further.

Computer science is typically regarded as a math-related field, and these findings may be linked to the gender differences reported in perceived self-efficacy in the mathematics domain as well (Betz & Hackett, 1981; Hackett, 1981). Hackett (1981) showed that perceived mathematics self-efficacy affects math-related career choices. In a similar manner, gender differences in computer self-efficacy may be an important contributor to differential enrollment in computer science courses in college.

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Table 1

Mean differences for men and women on the perceived self-efficacy and cognitive measures

Variable	Males (N=104) M	Males (N=104) SD	Females (N=264) M	Females (N=264) SD	F (df)	p
Self-efficacy for computer programming	46.20	29.28	26.23	26.20	40.26(1,365)	$<.001$
Self-efficacy for computer coursework	56.04	32.22	37.65	31.77	24.09(1,361)	$<.001$
Self-efficacy for personal uses of computer	55.54	34.90	39.13	32.98	17.36(1,361)	$<.001$
Plans to take a first college cs course	3.76	1.23	3.27	1.25	13.05(1,302)	$<.01$
Plans to take an additional cs course	3.92	1.22	2.58	1.39	14.36(1,54)	$<.001$
Relevance of computing skills to a future career	4.03	1.03	3.55	1.05	15.39(1,360)	$<.001$
Interest in knowing how a computer works	3.68	1.21	3.04	1.24	19.11(1,360)	$<.001$

Table 2

Correlations between the perceived self-efficacy scale and the behavioral and cognitive outcome measures

	Perceived computer self-efficacy
Completion of a high school computer programming course	.29
Past enrollment in a college computer science course	.47
Current enrollment in a college computer science course	.31
Plans to take a computer science course if the student has not already done so	.19
Relevance of computing skills to a future career	.39
Interest in learning how a computer operates	.31

All $p < .001$